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The nature and extent of systems analysis in education is discussed in terms of the following specific applications: (1) Instructional systems where the concern is with the components of the system (e.g., teachers, students, material to be taught, or audiovisual systems) and their interaction in the learning process. (2) project management systems for the planning and controlling of a wide variety of educational projects. (3) management information systems for better decision making by chief school officials. (4) planning-programming-budgeting systems for selecting among alternatives to reach program goals, and (5) operations research which attempts to identify the relevant variables making up the total system and subsystems and to secure quantitative data for each variable. Two problems involved in discussing systems analysis in education--terminology and the difficulty of securing evidence about its impact and application--are outlined. Warnings and recommendations regarding the role of systems analysis in education are presented. (HW)

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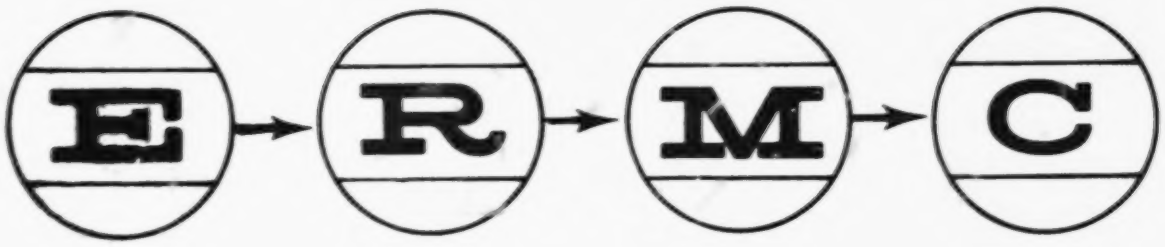

THE IMPACT OF SYSTEMS ANALYSIS ON EDUCATION

by

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U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

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THE IMPACT OF SYSTEMS ANALYSIS ON EDUCATION[1]

Desmond L. Cook

Introduction

According to the program outline, I have been given the assignment of speaking to you about the impact of Systems Analysis on Education as a follow-up to the excellent remarks just made by Steve Knezevich on the relevance of Systems Analysis to Educational Administration. More specifically, I have been asked to address myself to the nature and extent of Systems Analysis in Education by providing illustrative applications of this concept.

In organizing my thoughts for this presentation, I found myself dealing with a couple of major problems which I feel must be dealt with before any discussion of applications and/or impact on education. I would like, therefore, to outline these two general problems first and then follow this discussion with some examples of applications as I have encountered them and then conclude with some selected remarks which take the form of warnings and recommendations regarding the role of Systems Analysis in Education.

The Terminology and Evidence Problems

In my opinion, any discussion of Systems Analysis in the field of education is presented with two major problems. The first problem centers around the terminology relating to this area while the second problem relates to evidence regarding both impact and application of the several concepts in the field of education. Let me deal with each of these in turn.

It seems to me that we are at times rather loose with regard to our use of such words as Systems Analysis in the field of education. We sometimes use the word generally to refer to a systems approach or systems philosophy while at

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[1] A Paper presented at a Seminar on Systems Analysis, Department of Educational Administration, Temple University, Philadelphia, Pa., April 18, 1968.

other times we want to restrict its meaning to the specific interpretation presented by Hitch and McKean in their monograph The Economics of Defense in a Nuclear Age (3). wherein they make specific reference to the term in talking about the role of the Planning--Programming--Budgeting--System as used in the Department of Defense. At other times, I find that individuals are using such concepts as cost/effectiveness, operations analysis, input/output analysis, operations research as synonyms for each other. I am sure that purists associated with each of these concepts would not readily agree that they are, can be, or even should be used interchangeably. Further, I have encountered individuals who want to use the term systems in a singular sense and talk about the procedures and techniques of system analysis. This use of the concept is not the same as the systems analysis concept presented by Hitch and McKean and others.

I am not sure I can straighten out the terminology problem but I feel that in any discussion of this topic some effort must be made to make sure that the various concepts are clearly defined. For those of you interested in securing more concrete definitions of each of the above concepts, let me suggest that you read the little book by Hanika titled New Thinking in Management (1). This book attempts to give brief definitions and illustrative examples of the concepts presented above.

To raise the question of terminology without trying to answer it is somewhat of an irresponsible act. I have often approached the problem of Systems Analysis by defining what I feel a system to be. In general, I define a system to be a series of interrelated and interdependent parts designed to accomplish a goal or objective. As Sisson (5) points out, however, a system can be anything we want it to be and the problem is to define the boundaries of what should be included or would not be included within the system. A system, once identified, can be broken

out through a process of disassembly into a series of subsystems or a process of noting the variables making up the system. Once disassembled, we can study the interaction of the various variables through a process of assembly which is sometimes referred to as system synthesis. The processes of disassembly and assembly reflect our desire to first study the system and its components in order that we might reconstitute or reorganize it in order to make the system effective. Unless we develop some criterion of effectiveness, this process cannot assure us that we have any better product than when we started.

To bring some still further order into our thinking regarding systems concepts and their application in education, it might be helpful for us to employ the systems philosophy idea suggested by Hitt (4). The general characteristics of systems philosophy as described by Hitt consists of (a) a problem being considered in its broadest context, (b) placing emphasis on the functional relationships between the variables in the system, (c) investigation of the interactions between the variables along with their main effects, and (d) placing emphasis on the study of models which are developed to represent the actual system. The employment of such a philosophy might well enable us to deal with the many confusing terms which are now present when one attempts to deal the use of Systems Analysis in education.

The second problem to which I referred, that of securing evidence on the applications and impact of systems concepts in education, focuses upon the idea that many of the applications are fugitive in nature in the sense that one cannot easily identify the place and/or situations in which systems concepts are being employed, let alone assess their impact. This is primarily a dissemination and documentation problem but it does prevent one from identifying a variety of specific applications which could be used as examples. The problem is further complicated by the fact that most applications of systems concepts tend to be made within the system itself. That is, to part of the total education system rather than to

education as a total system. Putting it another way, many of the applications are at a subsystem level without an identification of the total system. Because of these circumstances, it would be perhaps somewhat premature as well as difficult to be able to make any substantial statement regarding the impact of systems concepts on the field of education at the present time.

With these two problems set before you let me now turn my attention to identifying some applications of systems concepts in education as I have encountered them during the past two or three years.

Some Applications of the Systems Philosophy to Education

Before describing some specific applications let me present a general observation of mine relative to such applications. This observation centers around the idea that in many of the applications there has been a primary if not exclusive concern with variables which are readily, or so at least it seems, quantifiable. This has occurred because many representations or models of systems take the form of mathematical formulations and notations as a way of representing the system under concern. In order for an individual to work with these mathematical formulations, it is necessary to have the variables expressed in some quantitative form. This situation is quite disturbing to many educational personnel because they recognize that many of the variables cannot, at least at the present time, be expressed in quantitative terms. To such persons, the variables are very qualitative in nature and the translation of them into qualifiable terms is alien to both their ration and emotion. To be fair to those using such representations of systems, this problem is recognized by them and in many cases there is a willingness to accept imprecise statements of qualitative variables in order to do the analysis.

To those of you who have concern over the representation of systems by mathematical formulas, I would call your attention to the fact that an <u>equally</u>

valuable way of representing systems is through some type of descriptive flow-graph procedure. As Hitt points out it may well be that ". . . we will not be able to apply refined mathematical models to these problems, and will be able to make use of only the descriptive flow-diagram type of model." We should therefore keep in mind, when talking about specific applications, that our concern is not alone with mathematical models for representing the system under consideration.

With the above observation as a background, let me present to you some specific applications of the systems philosophy in the field of education. It is only fair to point out that these applications stem primarily from my own experience and/or interaction with them and therefore may be somewhat limited in scope. Further, because of time limitations they will necessarily have to be limited in detail. For convenience, I have placed them in several different categories. The categories are not intended to be exhaustive nor are they mutually exclusive.

Instructional Systems. One of the most widespread applications of systems concepts in the field of education are those relating to the analysis of instructional systems. In this type of application, the concern is with the components of the system which might consist of teachers, students, material to be taught, employment of audio-visual systems and their interaction in the learning process. Many flow-graph models have been developed of these components as they might be re-structured to improve the learning process. One of the major applications of the systems concepts within in this application is in the area of computer-assisted instruction which attempts to establish a man-machine system for instructional purposes.

Project Management Systems. A second major application of systems concepts centers around the employment of various management systems for the planning and

controlling of a wide variety of projects in the field of education. Within this area, there is a widespread and ever increasing use of network-based management systems (such as PERT and CPM) for the better planning and control of such activities as Title I and Title I and Title III projects, school building construction, curriculum development, and similar non-repetitive tasks. Within this type of application, a project is conceived of as a system and is represented by a flow-graph, usually an arrow diagram or network, showing the flow of activities necessary to accomplish the project. The application of such techniques enables the school administrator to better integrate the variables of schedules, budgets, and performance in order to achieve optimal project or program efficiency. The focus of the Educational Research Management Center at Ohio State University has been primarily on the application of management systems of the network type to a wide variety of educational projects. We are currently undertaking a study of the nation's school districts in order to determine the extent and depth of the application of network management systems in the field of education. Our present knowledge indicates that such systems are being used much more extensively than reported in the educational literature.

Management Information Systems. A third type of application can be identified and is, in a general sense, the development of management information systems for better decision-making on the part of chief school officials. The basic essential of a management information system is the establishment of "data base" which can be used not only for operational control of the school on a day-to-day-basis but also as a source of information for long-range planning within the school district. The information base generally consists of data elements relating to faculty, students, finance, research and similar variables which can be organized into information useful to the school district in making its decisions. One illustrative application of this concept would be the Iowa Educational Information Center

currently underway in the state of Iowa with which some of you might be already be familiar. The crucial dimension of such information systems is the identification of the requirements or needs on the part of the users. That is, we need to know the decisions that have to be made and the proceeds involved in making them. In some cases, there is a tendency to select and store information without really determining its relevancy. The functional use of such systems often depends upon the use of computers in order to provide rapid access to the information as needed. The concept of management informations systems in business and industry has progressed much further than that in education but we can learn from their experience as we begin to develop and implement such systems.

Planning-Programming-Budgeting System. One of the newest and perhaps most controversial of the systems applications being made in the field of education at the present time is the employment of the Planning-Programming-Budgeting System developed by the military for use in selecting among alternatives to reach program goals and developing a schedule for acquisition of the selected alternative along with the immediate as well as long-range dollar cost.

One of the basic elements of the total system is the establishment of goals and then the development of alternative plans for reaching the goal. Each of the alternatives is considered as a separate system consisting of the personnel, facilities, and related items needed to achieve the objective. The term systems analysis is often applied to the analytical functions necessary to determine the components of each alternative and their inter-relationships. Further, each of the alternatives is considered in terms of its benefits for an associated cost. For this reason, the term cost/benefit analysis has often applied to the selection of alternatives in the planning phase.

The application of PPBS requires some quantification of the benefits to be gained from the alternative programs available. As you might guess, since many

of the benefits to be gained from education are largely qualitative extensive application of this system concept has not progressed too rapidly. The PPBS system also makes rather extensive use of mathematical formulas in order to rerresent models of the several alternatives. One of the principal functions of the PPBS system is to enable us to make better choice among alternative programs when limited resources are available to us.

Individuals interested in studying the applications of PPBS to the field of education should become familiar with the documents issued by State-Local Finances Project (2) being carried on at George Washington University in Washington, D. C. The basic purpose of this project is to translate the concepts of PPBS as developed in the military to other sectors of the economy.

I should point out at this time that PPBS is sometimes confused with a concept called program budgeting. These two ideas are basically different from each other. Program budgeting generally refers to a financial accounting system which assigns cost to objectives rather than to traditional categories such as personnel, services, travel, and similar items. Its use is gaining in popularity in the field of education.

Operations Research. The last major application of the systems philosophy I should like to discuss is that represented by the Operations Research approach to educational problems. This type of application attempts to identify the relevant variables making up the total system and sub-systems and securing quantitative data for each variable. The variables and the associated data are inserted into mathematical formulas in order to determine what effect on an output, which is usually student achievement, there might be for possible changes in the input.

This type of application is often also referred to as Operational Analysis where the basic intent is to develop a model which can be used to study the system. The model then can be used to make predictions without direct intervention in the

operations of the school district represented by the model. A closely related concept is known as Simulation.

For those interested in learning more about these approaches, I would suggest you become familiar with the work being done by Roger Sisson at the Management Science Center at the University of Pennsylvania. This project is devoted to the study of the applications of operational research to the management of education. I would also suggest that you become familiar with the proceedings of the Operations Analysis of Education Symposium which was held in Washington, D. C. during November of 1967. It is my understanding that the proceedings of this Symposium will be available later this year. Many of the applications I have discussed in this paper are illustrated in the proceedings.

The above brief description of the application of various systems concepts to education will perhaps give you some idea of the extent to which systems concepts have already permeated educational thinking. Many of these applications are essentially feasibility studies and therefore are not truly operational. On the other hand, others have become an accepted way of looking at educational problems. Whether operational or not, the interest in these techniques indicates that the applications of a systems philosophy to education is here and it requires that we become familiar with the concepts and principles involved.

Summary

In conclusion, it would be safe to state that the systems concept has had and will continue to have an impact on the field of education. Since the use of systems concepts is increasing, I would like to share with you some concerns I have about the expanding use of the concept.

I would hope that as we study and implement the systems approach that we give more emphasis to the development and understanding of processes and the

creation of attitudes favorable to their use than we do on the development of actual physical products (6). For example, in our work with the applications of PERT we have concern about the development of an actual network but we are more concerned with the understanding that the person acquires regarding under what conditions it is used, how it should be used, and that he be favorably disposed to use it.

I also feel that the impact of systems concepts is going to require some adjustment or modification of the training of educational administrators. It would appear to me that more time is going to have to be spent on such topics as management, management systems, information management, systems concepts, and related topics if the educational administrator of both the present and the future is to better understand the wide variety of systems applications being made.

As we discuss today the applications of systems concepts to education, we must remember that for many this will represent a change in behavior and mode of thinking. We should be aware of the fact that there will be resistance to such concepts for a wide variety of reasons. To gain acceptance of these ideas, it will be important for us to keep in mind the various factors related to resistance in the change process and be prepared to deal with them.

In conclusion, it is my firm conviction than not only have systems concepts had an impact on education albeit hard to measure but they will continue to do so in the future. This seminar is therefore very timely in terms of current interest in the topic. I trust that it will not only be timely but also stimulating so that each of you will make an effort to become more familiar with systems philosophy as you carry out your daily task of administering the nation's schools.

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